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EXTRACTION OF ALUMINA FROM CLAY

In the early days of the war, shipping losses cut imports of bauxite, the principal aluminum-bearing ore, to a point that seriously endangered the aluminum industry. Funds were made available by the War Department for the construction of a pilot plant at the Bureau to extract alumina from abundant American clays. Difficulty in obtaining equipment hampered construction, but by May 1943 a small plant capable of producing about 50 lb. of alumina a day had been built. Since then the plant has been operated and improved, but certain phases, such as calcination of the oxide and recovery of acid, require further work.

The process consists in (1) roasting clay at about 700° C to render the alumina soluble, (2) leaching the roasted product with dilute hydrochloric acid, (3) filtering to separate the insoluble siliceous matter from the solution containing the aluminum and soluble impurities such as iron and alkali salts, (4) concentrating the solution, (5) precipitating the aluminum as the hydrated chloride from the concentrated solution, (6) removing the crystals of hydrated aluminum chloride by centrifuging in a rubber-coated centrifuge, (7) washing the crystals to remove adhering impurities, (8) calcining the hydrated chloride to obtain alumina and to expel combined hydrochloric acid which is used in the next cycle, and (9) recovering hydrochloric acid from the waste products at the end of the process.

The alumina obtained in this pilot plant has an average purity of about 99.6 percent, the significant impurities being 0.25 percent of chlorine, 0.02 percent of iron, and 0.05 percent of silicon. This compares favorably with alumina produced from high-grade bauxite ores. For some uses, the alumina possesses exceptional properties, for example, as a polishing material for metallographic specimens and as the raw component of certain heat-resisting enamels.

No recent cost estimate has been made, but about 1 year ago it was indicated that alumina made by this process would be approximately twice as expensive as the regular commercial product. However, reduction in the price of hydrochloric acid when bought in large quantities and improvement in plant operation should materially reduce this figure if a shortage of bauxite ore ever again threatens the industry.

[1] Published with approval of the Director of the Budget.

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STRESS-CORROSION OF MAGNESIUM-BASE ALLOYS

The susceptibility to stress corrosion of the popular magnesium-base alloys (about 95 percent magnesium, balance chiefly aluminum and zinc) is a matter of extreme interest to users. Surface treatments have been developed that render these alloys practically immune to ordinary corrosive attack, provided the specimen is not stressed; but the simultaneous action of stress and corrosion materially shortens the life of the specimen. Stress-corrosion failures have been observed in such mildly corrosive media as atmospheric exposure in semiindustrial areas; they are more pronounced in specimens exposed to marine atmospheres or immersed in sea water. Laboratory tests have shown that the unstressed alloys last indefinitely when immersed in an aqueous solution of 2 percent potassium chromate plus 3 percent sodium chloride, but that stressed specimens fail in a manner similar to the stress-corrosion failures in other media, and in a matter of minutes or even seconds if the stress is high enough. Results of these laboratory tests are expressed in terms of the "critical stress", i. e., the stress that causes the specimen to fail within 48 hours, immersed in the test solution. The critical stress, in general, appears to be at least 70 percent of the yield strength and, for some of the more resistant compositions, it may be as high as 95 percent.

DIAGRAMS REPRESENTING COHESIVE STRENGTHS OF METALS

From two-dimensional diagrams based on experiments of several investigators, D. J. McAdam, Jr., chief of the Bureau's section on thermal metallurgy, has derived three-dimensional diagrams to represent the technical cohesive strengths of brittle and ductile metals. As explained in an article which has been prepared for publication in "Metals Technology," a single diagram may be used to represent resistance to cleavage and to shearing fracture. The cohesive strength of a brittle metal is represented by a surface symmetrical with reference to the locus of polar-symmetric stresses and either circular or hexagonal in cross section. The surface tapers nonlinearly to the point representing the disruptive stress. A similar surface may be used to represent the *initial* technical cohesive strength of a ductile metal. The ideal locus of fractures of a ductile metal has either circular or scalloped hexagonal cross section.

DEOXIDIZED ACID BESSEMER STEEL FOR HIGH PRESSURE, HIGH TEMPERATURE PIPING

For many years Bessemer steel has been considered brittle, and consequently its use has been restricted largely to structures or parts in which this property was not important. However, a decided improvement has been made in this type of steel, so that a modern variety may now be obtained having properties vastly superior to those of the older type. This improvement has been brought about largely by controlled deoxidation of the steel during its manufacture. Many of the mechanical properties of these fully killed acid Bessemer steels are similar to those of open-hearth steels and they may be used interchangeably in some applications. The old prejudice against Bessemer steels, however, still persists in many quarters.

At the request of the United States Coast Guard, George A. Ellinger and Morgan L. Williams of the Bureau's Metallurgy Division recently completed a comparison test of fully killed acid Bessemer steel pipe and open-hearth steel pipe of the type used for high temperature, high pressure steam service in merchant ships. The yield strength and tensile strength of the Bessemer steel were somewhat higher than those of the open-hearth steel, whereas the elongation was slightly lower. Notched bar tests (using special subsize Charpy V notch specimens) in the temperature range 925° to −50° F indicated that the impact properties of the fully killed Bessemer steel were as good or better than those of the open-hearth steel.

FIRST TWO SPECTRA OF COLUMBIUM

John Winthrop (1606–1676), first governor of Connecticut, took pleasure in collecting minerals. Near his home in New London, he found a black rock (now known as columbite) which his grandson sent to London where it was placed in the British Museum. In 1801 Charles Hatchett (1765–1847), an English chemist, fused the ore with potassium carbonate. When he took up the melt with boiling water, a brown residue resulted. When nitric acid was added to the yellow filtrate, a copious white precipitate was thrown down. "The

preceding experiments shew," said he, "that the ore which has been analysed consists of iron combined with an unknown substance." Hatchett named the new element *columbium*, but he did not succeed in reducing the compound to metal.

Columbium, as a shining steel-gray metal, was first prepared in 1864, but for more than 6 decades the few tiny specimens available were regarded as scientific curiosities. However, in 1929, C. W. Balke of Chicago exhibited before the American Chemical Society, large sheets and rods of this rare metal, and industrial uses of columbium began immediately. Recently, the addition of columbium and other metals to iron has resulted in revolutionary types of steel alloys which are now so complex that chemical analyses for composition control during production can be efficiently made only by spectrographic methods.

Between 1895 and 1910 several attempts were made to describe the emission spectra characteristic of columbium. Twenty years ago, these early data were examined in the Bureau's Spectroscopy Section. As a result, the first regularities in columbium spectra were discovered, and it was concluded that improved descriptions of the spectra were desirable. From time to time new observations were made on wavelengths, relative intensities, ionization stages, and the behavior of spectral lines in a magnetic field (Zeeman effect). The structural analyses of the first two spectra of columbium were prosecuted until 95 percent of the total observed intensity was accounted for by identified atomic energy changes.

In order to facilitate spectrochemical analyses of alloys containing columbium, the best information now available for the first two spectra has been prepared for publication by Curtis J. Humphreys and William F. Meggers, and will appear as RP1656 in the June number of the Journal of Research. The total number of lines definitely characteristic of neutral columbium atoms is 3,313, of which 2,836 are interpreted as combinations of 364 identified atomic energy states. The number of lines ascribed to singly ionized columbium atoms is 1,723, of which 1,494 are explained as transitions between 183 ionic energy levels.

REFRACTIVE-INDEX STANDARDS OF FLUORCROWN GLASS

Fluorcrown glasses provide the only solid standards available for testing refractometers in the refractive-index range 1.46 to 1.50—a range which is much used for measurements on various liquids. Since heat and cold have but little effect on the optical properties of these glasses, it is especially desirable to use them as standards whenever it is necessary to work at very high or low room temperatures.

The calibration of fluorcrown standards may be facilitated by comparisons with data tabulated for six of these glasses in RP1659, a paper by Leroy W. Tilton in the June Journal of Research. Precise indices are given at 5° intervals from 15° to 55° C. The care necessary in order to avoid errors caused by the surface weathering of some of these glasses is discussed, and certain bright bands that occasionally are visible in the dark portion of the refractometer field are interpreted as critical-angle phenomena corresponding to decomposition products in the surface layers.

INFLUENCE OF VARIOUS CURING METHODS ON CONCRETE

Comparative strength and wear tests of portland cement concrete are reported in an article prepared by H. C. Volmer for publication in the Proceedings of the Highway Research Board. The concrete specimens were stored at 70° F and 50- to 60-percent relative humidity. Six methods of curing—burlap, integral, and surface calcium chloride, and three samples of sprayed surface membranes—were used. Damp burlap for 18 hours, with calcium chloride used either integrally or spread on the surface upon removal of the burlap, gave 28-day strengths of the same order as the 3-day wet-burlap method. The strengths obtained with the three sprayed membranes were lower. Compared to the specimens cured with burlap for 3 days, the specimens cured with surface or integral calcium chloride had higher wear resistance, and specimens cured with the three membranes had lower wear resistance.

EFFECT OF LENGTH ON THE STRENGTH OF CONCRETE TEST SPECIMENS

When compressive-test specimens of concrete are shorter than twice their least width it is customary to adjust the test values by the use of a single set of correction factors, such as those in Standard Method C42-44 of the American Society for Testing Materials, the corrections depending only upon

the ratio of length to least width. A paper which John Tucker, Jr., has prepared for publication in the ASTM Proceedings demonstrates that the extent of the variation in strength with length is dependent upon several distinct factors. For example, the relation between the strength and slenderness of a specimen varies with the strength of the concrete, and therefore the use of a single set of correction factors is not warranted. Much more reliable estimates of strength may be obtained by limiting the range of slenderness values to those for which the correction is small, even though this may require diameters less than those usually considered acceptable. Although the numerical values that are given apply to concrete, the principles are applicable to other brittle materials.

DIAMOND-IMPREGNATED CUTTING WHEEL FOR PREPARING TEST SPECIMENS OF PLASTICS

Experience at the Bureau in the use of the diamond-impregnated cutting wheel has shown that this equipment is satisfactory in all respects for preparing test specimens of thermosetting plastics, thermoplastics containing a high proportion of glass or mineral filler, and unplasticized rigid thermoplastics, such as styrene and methyl methacrylate resins. The quality of the cuts is very good, and the method is rapid and inexpensive. In an article by Frank W. Reinhart in the June number of Modern Plastics, special procedures are described for making tensile and tensile-shear specimens with this type of equipment. This cutting wheel will not cut soft materials or the hand of the operator, and is made of a metal that permits pressure to be applied to the side of the wheel without danger of fracture; these factors make its use practically nonhazardous.

STABILITY OF LUBRICATING GREASES

Greases deteriorate in service primarily because of (a) breakdown of the grease structure, (b) absorption of water, and (c) change in composition resulting from oil evaporation and from oxidation.

Investigations at the Bureau on working of greases have shown that they differ markedly as regards the rate of breakdown of the grease structure, dependent upon the characteristics of the oil and soap used in their manufacture, but particularly upon the percentage of soap used. No grease has been tested thus far that does not continue to break down with increased working. However, it has been found possible to produce greases in which this breakdown takes place so slowly that it is not serious. This is true of very few commercial greases.

Greases also have been found to differ greatly as regards the effect of water, depending upon the nature of the soap used in their manufacture. New test methods have been developed for water resistance of greases, and also for loss of oil by evaporation at elevated temperatures.

These conclusions—the results of an intensified study of greases for military needs—have led to renewed activity on the part of manufacturers; this can hardly fail to result in marked improvement in the greases available for civilian use.

TRANSFER STRAIN GAGE FOR LARGE STRAINS

A simple and inexpensive strain gage, having a range of —16 to +32 percent on a 1.5-inch gage length, has been devised by Martin Greenspan and Leroy R. Sweetman of the Bureau's Engineering Mechanics Section and is being used successfully for determining the stress-strain relations in the plastic range of some aluminum alloys and steels.

As described in the June Journal of Research (RP1658), the gage consists of two distinct steel blocks equipped with steel knife edges (or conical points) that are kept in contact with the specimen at each end of the gage line by means of spring clips. The blocks move in relation to one another when the length of the gage line changes, but are kept in alinement by a rod which is attached to one block and passes through a hole in the other.

One block, known as the "indenter block," carries a hardened steel indenter mounted on a cantilever leaf spring; the other block, called the "target block," has a brass target cemented to it. The gage is operated by depressing the spring manually so that the indenter leaves a small mark on the target. By successive depressions a record of the deformations of the gage line corresponding to the loads is thus transferred to, and preserved on, the target, from which it is read after the test is completed by means of a traveling micrometer microscope.

COMMERCIAL STANDARD FOR MASTER DISKS

Commercial Standard (Emergency) CS (E) 124–45 for master disks has just been released in printed form.

The project was initiated on request of the War Production Board, and the standard was developed through the voluntary cooperation of the industry with the Bureau, other Government agencies, distributors, and users. It covers the major essential material and dimensional requirements for master disks in the American Gage Design styles in sizes from above 0.105 inch to and including 8.010 inches, as well as specifications for hardness, finish, accuracy tolerances in three classes, and methods of test.

In addition, the standard sets up requirements for packing and for marking master disks, where practicable, with size designation and manufacturer's name or trade-mark. The standard further recommends that the individual manufacturers include in their catalogs, sales literature, and packing lists, appropriate declarations of compliance with this commercial standard.

The industry expects that the standard will provide a basis for better understanding between buyers and sellers, as well as a foundation for fair competition and identification of master disks conforming to the standard.

Printed copies are obtainable from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at 5 cents each, with a discount of 25 percent on orders of 100 or more to a single address.

COMMERCIAL STANDARD FOR WESTERN HEMLOCK PLYWOOD

Printed copies of Commercial Standard CS122–45, Western Hemlock Plywood are now available. This pamphlet sets forth definite grading requirements for four grades of western hemlock plywood, bonded with a moisture-resistant-type adhesive. These grades are suitable for sheathing, paneling, subflooring, and many structural and industrial uses when not subjected to exterior exposure. In addition to the grading requirements, the standard covers tests for bondage, standard sizes, size tolerances, reinspection rules, grade marking, and nomenclature and definitions.

Developments during the past several years have brought western hemlock, and to some extent the commercial white firs, into the plywood manufacturing field. The scarcity of high-grade Douglas fir peeler logs has led several mills to use these woods in supplying urgently needed plywood in the lower grades to the armed forces for building construction. Full production has thus been maintained.

In order to keep the commercial standard abreast of progress in the manufacture of plywood and of experiences gained from its distribution and use, a representative committee of manufacturers, distributors, and users will from time to time consider revisions. The personnel of this committee is listed in the pamphlet, which also includes a brief history of the project and a list of acceptors (organizations and individuals). The standard became effective for new production on March 5, 1945.

Printed copies of CS122–45 are obtainable from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.; the price is 5 cents.

REVISED SIMPLIFIED PRACTICE RECOMMENDATION FOR FILES AND RASPS

The proposed revision of Simplified Practice Recommendation R6–44, Files and Rasps (American Pattern, and Straight- and Curved-Tooth Milled Files), having been accorded the required degree of acceptance by manufacturers, distributors and users, became effective on May 1, 1945.

The revision makes twelve departures from the superseded issue. The width and thickness dimensions of some of the sizes and types, which had been reduced as a conservation measure, have been restored; several sizes of flat brass files and hand-saw blunt files have been added, also second-cut in five sizes of mill files. One size in each of six other types is eliminated.

Until printed copies are ready, a limited number of mimeographed copies are available free of charge on addressing the Division of Simplified Practice, National Bureau of Standards, Washington 25, D. C.

NEW HANDBOOK ON PROTECTION AGAINST LIGHTNING

The Bureau, in cooperation with the American Institute of Electrical Engineers, under the procedure of the American Standards Association, has for the past 24 years sponsored a "Code for Protection against Lightning"

(Technical News Bulletin 250, February 1938). A new edition of this publication is now available as National Bureau of Standards Handbook H40, obtainable for 20 cents a copy from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Part I of the Handbook deals with the protection of persons and warns against taking shelter under a large single tree in a field or getting too close to a wire fence. On the other hand, it is pointed out that a forest is a relatively safe place, provided one does not get under a tree that projects above its neighbors.

Part II deals with the protection of buildings and sets up standards for adequate rodding of such structures. Lightning rods are recommended for tall or isolated frame or masonry structures but are generally unnecessary for steel framed buildings since the steel frame is itself a good lightning rod. In some buildings with steel skeletons, points are provided at the top to protect stone copings or chimneys, those points being connected to the steel frame.

Part III covers structures containing flammable liquids. Developments during the past 7 years have made it necessary to rewrite completely this portion of the code, which now offers a number of modern methods for protecting oil refineries, tank farms, and the like. This revision was prepared by a representative committee headed by W. W. Lewis, of the General Electric Co., a nationally known authority on lightning and lightning protection. As a war measure it is vitally important to safeguard the nation's supply of petroleum in storage, in process of manufacture, and in final form as gasoline, fuel oil, and the thousands of other necessary products made from it. The revised part III should help in the protection of this vital oil supply from one of its greatest hazards.

Two halftones showing a lightning flash as photographed with a moving and with a stationary camera, and four line drawings of typical protective installations, as well as a very complete bibliography on lightning and the protection of structures against lightning, are included.

NEW AND REVISED PUBLICATIONS ISSUED DURING MAY 1945

Journal of Research [2]

Journal of Research of the National Bureau of Standards, volume 34, number 3, March 1945 (RP1638 to RP1644, inclusive). Price 30 cents. Annual subscription, 12 issues, $3.50.

Journal of Research of the National Bureau of Standards, volume 34, number 4, April 1945 (RP1645 to RP1650, inclusive). Price 30 cents.

Title page, corrections, and contents for volume 33, Journal of Research, July to December 1944 (RP1592 to RP1623, inclusive). Price 5 cents.

Research Papers [2]

[Reprints from February 1945 Journal of Research]

RP1631. Application of the Ilkovič equation to quantitative polarography. Floyd Buckley and John Keenan Taylor. Price 10 cents.

RP1632. Comparative liquid-junction potentials of some pH buffer standards and the calibration of pH meters. George G. Manov, Nicholas J. DeLollis, and S. F. Acree. Price 5 cents.

RP1633. Spectrographic determination of sodium, potassium, and lithium in portland cement with the direct-current carbon arc. Armin W. Helz. Price 10 cents.

RP1634. Heats, free energies, and equilibrium constants of some reactions involving O_2, H_2, H_2O, C, CO, CO_2, and CH_4. Donald D. Wagman, John E. Kilpatrick, William J. Taylor, Kenneth S. Pitzer, and Frederick D. Rossini. Price 10 cents.

RP1635. Heats of isomerization of the 18 octanes. Edward J. Prosen and Frederick D. Rossini. Price 5 cents.

RP1636. Region of usable imagery in airplane-camera lenses. Francis E. Washer. Price 10 cents.

RP1637. Relaxation of stresses in annealing glass. Arthur Q. Tool. Price 5 cents.

Handbook [2]

H40. Code for protection against lightning: Parts I, II, and III. (Supersedes H21.) Price 20 cents.

Simplified Practice Recommendations [2]

R62–45. Metallic cartridges. (Supersedes R62–44.) Price 5 cents.

R118–45. Abrasive grain sizes. (Supersedes R118–40.) Price 5 cents.

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[2] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Subscription to Technical News Bulletin, 50 cents a year; Journal of Research, $3.50 a year (to addresses in the United States and its possessions and to countries extending the franking privileges); other countries, 70 cents and $4.50, respectively.

Commercial Standards[2]

CS122–45. Western hemlock plywood. Price 5 cents.
CS(E)124–45. Master disks. Price 5 cents.

Technical News Bulletin[2]

Technical News Bulletin 337, May 1945. Price 5 cents. Annual subscription, 50 cents.

RECENT ARTICLES BY MEMBERS OF THE BUREAU'S STAFF PUBLISHED IN OUTSIDE JOURNALS[2]

Relation of pipe wall thickness to pipe life. K. H. Logan. Petroleum Engineer (Erwin-Keasler Bldg., Dallas 1, Texas), **16**, No. 6, 186 (March 1945).

Standard response functions for protanopic and deuteranopic vision. Deane B. Judd. J. Optical Soc. Am. (57 East 55th St., New York 22, N. Y.), **35**, 199 (March 1945).

Some factors affecting the precision in polarographic analysis. Floyd Buckley and John Keenan Taylor. Preprint 87–17 Electrochem. Soc. (Dr. Colin G. Fink, Secretary, 3000 Broadway, New York 27, N. Y.), (April 16, 1945).

Bonding new topping to old concrete surfaces. F. B. Hornibrook and Nathan Green. J. Am. Concrete Institute (7400 Second Blvd., Detroit 2, Mich.), **16**, No. 5, 516 (April 1945).

Pallet simplification, mass distribution. Alvin Hertwig. Domestic Commerce (Department of Commerce, Washington 25, D. C.), **33**, No. 4, 7 (April 1945).

Commercial standardization at the National Bureau of Standards. Iler J. Fairchild. The Washington Scientist (819 13th St. N. W., Washington 5, D. C.), **1**, No. 3, 46 (April 1945).

MIMEOGRAPHED MATERIAL

Letter Circulars

[Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards and are sent only on request to persons having a definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or send copies automatically as issued.]

LC790. Gases: Publications by the staff of the National Bureau of Standards. (Supersedes LC546.)
LC791. The mass spectrometer. (A brief popular description.)

[2] These publications are not obtainable from the Government, unless otherwise stated. Requests should be sent direct to publishers.

U. S. GOVERNMENT PRINTING OFFICE: 1945